

Documents Number:

RRCAT/LVCDS/CJQL/SCC/Disp/2010/01

Dispatch of prototype 1.3 GHz Single-Cell Niobium Cavities to FermiLab under IIFC Collaboration for processing and performance evaluation.




Raja Rammna Centre for Advanced Technology (RRCAT) has taken up development of prototype 1.3 GHz Single cell cavity under collaboration agreement between Fermi National Accelerator Laboratory (FNAL, USA) and Indian Institutions (IIFC) as per Addendum-I dated August 20, 2007 to the MoU. Two prototype single cell 1.3 GHz cavities have been fabricated and are now ready for dispatch to Fermilab for further processing and testing at 2K for cavity performance evaluation.

Present dispatch document include,

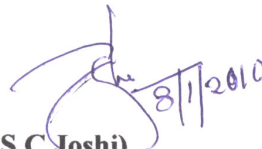
- 1) Technical descriptions & drawings details
- 2) Dimensional inspection report of the cavity
- 3) Various pre-dispatch qualification tests performed prior to shipment
- 4) Reference

Prepared by:

  
(M Bagre/ A Puntambekar)


CJQL/LVCDS

Checked by:

  
(S C Joshi)

Head, LVCDS

Approved by:

  
(Dr. P D Gupta)

Director, RRCAT

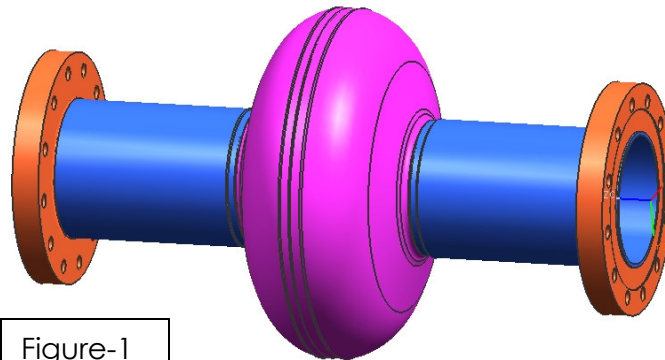
## 1. Technical description and drawings:

The 1.3 GHz single cell cavity is made based on standard TESLA shape design (DESY) provided by FNAL under IIFC collaboration.

These cavities have been manufactured as per drawings number RRCAT/AAMDD/1.3GHz/SCC/06 Cavity Assembly and inspected as per QA drawing number RRCAT/AAMDD/1.3GHz/SCC/QC/06. These drawings are given at the end of this document.

These are made with reference to FNAL drawings number: “5520.000-MD-457528-DESY-1.3 GHz TESLA SINGLE CELL RF CAVITY ASSEMBLY,

{Attachment rings have been eliminated from the basic TESLA design based on input from FNAL}. The 3D UG NX-4 model of the designed cavity is shown in Figure 1 (with attachment ring eliminated).



Forming of half cells was performed on the forming tooling developed at RRCAT in collaboration with FNAL. Design & development of various welding fixture was done at RRCAT. Machining of all the components was done at RRCAT workshop. Electron beam welding was performed under the (RRCAT\_IUAC) collaboration at the facility of IUAC, New Delhi. Various mechanical inspections, frequency measurement and joint qualifications were done at RRCAT.

### 1.1 Cavity Identification number :

First Prototype 1.3 GHz Single cell cavity : TE1CAT001 (Half cell ID: 125+127)

Second Prototype 1.3 GHz Single cell cavity : TE1CAT002 (Half cell ID: 138+139)

The material used was high RRR niobium sheets 2.8 mm for half cell forming, 3 mm thick for beam tube and the End Flanges were made from Nb-Ti55% bar stock provided by FERMI Lab.

Nb sheet reference number used for forming of half cells: FNAL- 039, 040,043 and 044

## 2. Dimensional inspection report of cavity

### Measurement Record

Title: 1.3 GHz Single cell Cavity Assembly

Assembly Name: Cavity assembly (Equator Weldment)

Drawing Number: RRCAT/AAMDD/1.3GHz/SCC/06

QC Drawing #: RRCAT/AAMDD/1.3GHz/SCC/QC/06

Assembly ID No. **TE1CAT001** (Half cell ID No. 125 + 127)

Measured Values:

Dimension ID	Component	Basic Size	Tolerance	Measured Value	Acceptance Yes/No	Remarks
SCC1	Length	392	$\pm 1$	393.5	Yes	
SCC2	Parallelism		0.1	0.14	Yes	
SCC3	Perpendicularity		0.1	Not performed		CMM limitation
SCC4	Concentricity		0.1	Not performed		

Inspection (Check)		Acceptance Yes/No	Remarks
Leak Test			
300 K	Helium Leak Rate $\leq 10^{-10}$ mbar l/s	Yes	
77 K	Helium Leak Rate $\leq 10^{-10}$ mbar l/s	Yes	
2 K			Not performed
Visual Check	All equator welding seams must be full penetration with no gaps or discontinuities. Under-bead smooth and protrusion relative to surrounding material not to exceed 0.1mm.		Full penetration at equator inside. Weld bead is good for 270° and minor undulation observed in remaining 90°.
	RF surface (inner surfaces) free of scratch marks	Yes	
	Sealing surfaces of the End Flange free of damage:	Yes	

Other Check	Value	Remarks
Frequency	(MHz)	
300 K	1296.926	
77 K	1298.726	
2 K	-	Not performed

Checked by:

Verified by:

Manish Bagre

Avinash Puntambekar

### Measurement Record

Title: 1.3 GHz Single cell Cavity Assembly

Assembly Name: Cavity assembly (Equator Weldment)

Drawing Number: RRCAT/AAMDD/1.3GHz/SCC/06

QC Drawing #: RRCAT/AAMDD/1.3GHz/SCC/QC/06

Assembly ID No. **TE1CAT002** (Half cell ID No. 138 + 139)

Measured Values:

Dimension ID	Component	Basic Size	Tolerance	Measured Value	Acceptance Yes/No	Remarks
SCC1	Length	392	$\pm 1$	392.97	Yes	
SCC2	Parallelism		0.1	0.54	-	
SCC3	Perpendicularity		0.1	Not performed		CMM limitation
SCC4	Concentricity		0.1	Not performed		

Inspection (Check)		Acceptance Yes/No	Remarks
Leak Test			
300 K	Helium Leak Rate $\leq 10^{-10}$ mbar l/s	Yes	
77 K	Helium Leak Rate $\leq 10^{-10}$ mbar l/s	Yes	
2 K			Not performed
Visual Check	All equator welding seams must be full penetration with no gaps or discontinuities. Under-bead smooth and protrusion relative to surrounding material not to exceed 0.1mm.		Full penetration at equator inside. Weld bead is good for 300° and minor undulation observed in remaining 60°.
	RF surface (inner surfaces) free of scratch marks	Yes	
	Sealing surfaces of the End Flange free of damage:	Yes	

Other Check	Value	Remarks
Frequency	(MHz)	
300 K	1296.675	
77 K	1298.675	
2 K	-	Not performed

Checked by:

Verified by:

Manish Bagre

Avinash Puntambekar

### 3. Various pre-dispatch qualification tests performed prior to shipment

The completed 1.3 GHz SC cavity was subjected to mechanical inspection, RF measurement at 300 K & 77 K and Vacuum leak qualification also at 300 K & 77 K.

3.1 Mechanical Measurements: Table 1 gives the results of various mechanical measurements.

	Length (mm)	Perpendicularity	Parallelism	Concentricity
Dwg FNAL No. 5520.000- MD-457528	392 ±1	0.40	Not shown	Not shown
Dwg RRCAT RRCAT/AA MDD/1.3 GHz/SCC/06	392 ±1	0.40	0.10	0.10
TE1CAT001	393.52	Could not be checked	0.14	Could not be checked
TE1CAT002	392.97	Could not be checked	0.54	Could not be checked

Table-1 Mechanical Measurement

3.2 RF Measurements : Table 2 gives the results of various Frequency and Q measurements of the final cavity.

Cavity ID	Length (mm)	Frequency (MHz) 300K	Frequency (MHz) 77K	Quality factor 300 K
TE1CAT001	393.58	1296.926	1298.726	9076
TE1CAT002	392.96	1296.675	1298.675	9328

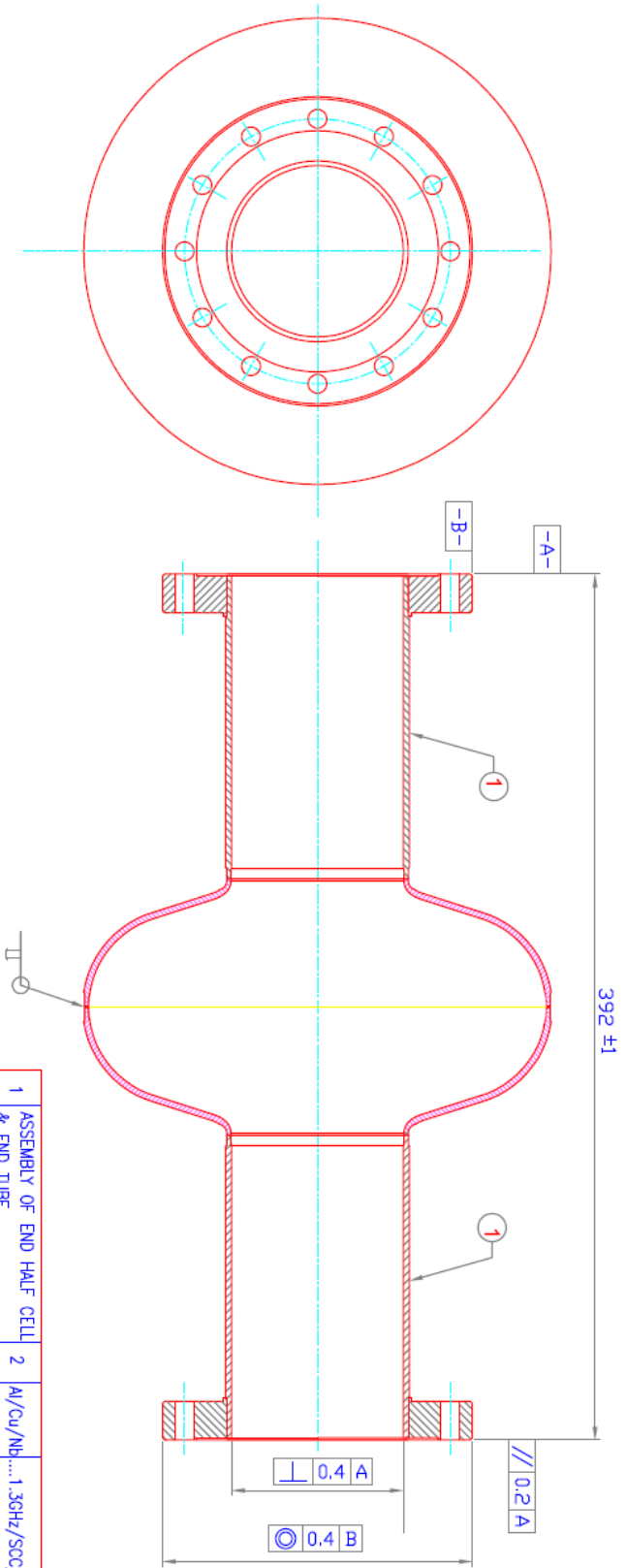
Table-2: Frequency Measurement

3.3 : Leak Testing : Both the cavities have been leak checked and qualified for leak rate  $< 1 \times 10^{-10}$  m-bar L/sec at 300 K & 77 K.



#### 4. Reference:

- [1] DESY- specification of welded 1.3 G Hz Superconducting resonator for TTF-FEL, D. Proch, MHF-SL, 1-1999
- [2] 3.9 GHz, 3rd Harmonic SCRF, Fabrication of the Niobium Cavity and End-Groups, FNAL Note 8/3/2005, Don Mitchell, Al Beutler, Mike Foley, Scott Reeves
- [3] 1.3 GHz TESLA cavity production and tuning at DESY, G. Kreps , DESY 2006 report
- [4] Private Communication with Mike Foley & Timergali Khabiboulline, FNAL.
- [5] FNAL reference No. 892851-1-“Procedure for Inter-facility Transport of 1.3 GHz One-cell SRF Cavities”



NOTES:-

1. ASSEMBLY TO BE VACUUM TIGHT. NO LEAK SHALL BE DETECTABLE ON THE MOST SENSITIVE SCALE OF A HELIUM MASS SPECTROMETER LEAK DETECTOR WITH A MINIMUM SENSITIVITY OF  $2 \times 10^{-10}$  mbar l/SEC FOR HELIUM.
2. ASSEMBLY TO BE CLEANED AND PACKAGED SO AS TO ASSURE NO CONTAMINATION FROM FOREIGN MATERIALS, METAL CHIPS OR OTHER CONTAMINATES.
3. ALL ASSEMBLY AND HANDLING IS TO CONFORM TO STANDARD ULTRA HIGH VACUUM PRACTICES.
4. PROTECT THE SEALING SURFACE DURING HANDLING.

FINAL REF DRG NO.:-  
5520.000-AD-457526

REV	LOCATION	DESCRIPTION	DATE	APPD
NO				

GENERAL TOLERANCES			
LINEAR	: ±0.1		
ANGULAR	: ±0.1°		
SURFACE FINISH : 1.6/√			
ROUND OFF ALL SHARP CORNERS TO 0.2 UNLESS OTHERWISE SPECIFIED			

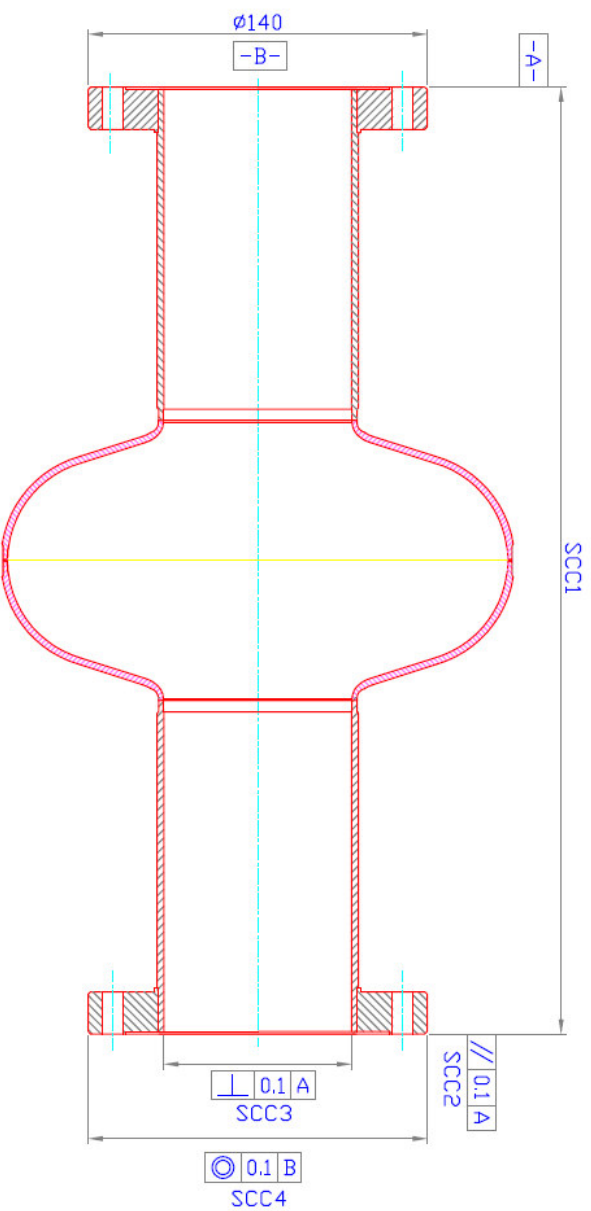
TITLE					
GOVERNMENT OF INDIA					
RAJA RAMANNA CENTRE					
FOR ADVANCED TECHNOLOGY					
ACCELERATOR PROGRAMME					
CAVITY ASSEMBLY					
(1.3 GHz SINGLE CELL SCRF CAVITY)					
DESD	DATE	CHKD	DATE	SCALE	
Thak Murya		Manish Bagre		NIS	
DRN	DATE	APPD	DATE		
ALLHegorann		A M Puntambekar			
ORIGINATING SECTION / GROUP				ADVANCED ACCELERATOR MODULE DEVISION	
DRG No. RRCAT/AAAMD/1.3GHZ/SCC/06				SIZE	SHEET
				A3	1 OF 1

PART No.	DESCRIPTION	QTY	MATL.	REMARKS
1	ASSEMBLY OF END HALF CELL & END TUBE	2	Al/Cu/Nb .... 1.3GHz/SCC/05	

BILL OF MATERIAL

ADD REF. BUTT JOINT CELL





# **NOTES:-**

1. ASSEMBLY TO BE VACUUM TIGHT. NO LEAK SHALL BE DETECTABLE ON THE MOST SENSITIVE SCALE OF A HELIUM MASS SPECTROMETER LEAK DETECTOR WITH A MINIMUM SENSITIVITY OF  $2 \times 10^{-10}$  mbar l/SEC FOR HELIUM TO BE TESTED AT ROOM TEMP AND CRYOGENIC TEMP.
2. THE FREQUENCY AND QUALITY FACTOR SHOULD BE MEASURED AT ROOM TEMP AND CRYOGENIC TEMP
3. ASSEMBLY TO BE CLEANED AND PACKAGED SO AS TO ASSURE NO CONTAMINATION FROM FOREIGN MATERIALS, METAL CHIPS OR OTHER CONTAMINATES.
4. ALL ASSEMBLY AND HANDLING IS TO CONFORM TO STANDARD ULTRA HIGH VACUUM PRACTICES.
5. PROTECT THE SEALING SURFACE DURING HANDLING.

<p>GOVERNMENT OF INDIA RAJA RAMANNA CENTRE FOR ADVANCED TECHNOLOGY ACCELERATOR PROGRAMME</p>					
<p>TITLE QUALITY CONTROL DWG FOR CAVITY ASSEMBLY (1.3 GHz SINGLE CELL SCRF CAVITY)</p>					
DESIGN	DATE	CHKD	DATE	SCALE	
Triak Maurya				NTS	
DRAWN	DATE	APPRO	DATE		
A.L.Narayanan		A. M. Purnambaker			
ORIGINATING SECTION / GROUP	ADVANCED ACCELERATOR MODULE DEV/DIVISION				
DRG No. RRCAT/AA/MD/1.3GHz/SCC/IC/06					SIZE A3
					SHEET 1 OF 1